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GEAR MECHANISM, IN PARTICULAR FOR HAND POWER TOOLS

Prior Art

The invention is based on a gear mechanism, in particular for hand power tools, as generically defined by the preamble to claim 1.

In gear mechanisms for hand power tools, sintered gear wheels with a spiral or straight gearing are used, for reasons of cost. Recourse to gear wheels that are cut, whose production costs are relatively high, is had only whenever stringent demands for running smoothness are made, in the case of high-quality appliances. Plastic gear wheels, which can be produced at a similar cost to sintered gear wheels, can transmit only low torques and are therefore used in hand power tools only in a few exceptional cases.

Pairs of gear wheels put together from sintered gear wheels have the disadvantage, dictated by their production, of major tolerances, which causes loud running noise and has an adverse effect on the service life.

Advantages of the Invention

The gear mechanism of the invention, in particular for hand power tools, having the characteristics of claim 1 has the advantage that because of the damping elements incorporated between the damping elements, preferably of rubber or rubberlike material with a high damping factor, that are incorporated between the driving gear wheel and the driven shaft and act in the circumferential direction or tangential direction, tolerances and in particular pitch errors, profile deviation and errors of concentricity,

1 existing in the paired gear wheels can not only be
2 compensated for, markedly lessening the gear noise and
3 vibration caused by the gear mechanism, but the very high
4 startup forces acting on the gearing, which occur when the
5 drive motor that turns the drive shaft upon being switched on
6 because of the inertia of the drive and of the driven masses,
7 and the load peaks that occur in operation at the gearing can
8 all be reduced. Overall, this leads to highly smooth running
9 in the case of sintered gear wheels, and regardless of the
10 type of gear wheels (sintered or cut), because of the reduced
11 mechanical load, the result is a long service life of the
12 gear mechanism.

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14 By the provisions recited in the further claims,
15 advantageous refinements of and improvements to the gear
16 mechanism defined by claim 1 are possible.

17
18 In a preferred embodiment of the invention, the driven
19 gear wheel is seated rotatably on the driven shaft and has
20 pockets, offset from one another in the circumferential
21 direction, that are defined by radial side walls. The damping
22 elements rest in the pockets with contact against the radial
23 side walls and are retained on a slaving device that is
24 joined to the driven shaft in a manner fixed against relative
25 rotation, which slaving device is fixed axially
26 nondisplaceably on the driven shaft.

27
28 In an advantageous embodiment of the invention, the
29 slaving device has a ring seated on the driven shaft in
30 force- and form-locking fashion and has a number of radial
31 ribs, corresponding to the number of pockets in the driven
32 gear wheel, of which each radial rib protrudes into one
33 pocket. In each pocket, there are two damping elements,
34 resting on each side of the radial rib, of which each damping

1 element is braced on one side on the radial rib and on the
2 other on a radial side wall of the pocket. The damping
3 elements may be placed in the pockets or joined to the radial
4 ribs, for instance spray-coated onto the radial ribs.

5 6 Drawing

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8 The invention is described in further detail in the
9 ensuing description in terms of an exemplary embodiment shown
10 in the drawing. Shown are:

11
12 Fig. 1, an exploded of an angular gear for a hand power
13 tool;

14
15 Fig. 2, a perspective view of the assembled gear
16 mechanism in Fig. 1;

17
18 Fig. 3, a matrix for clear comparison of possible
19 pocket and radial rib geometries in the gear mechanism of
20 Figs. 1 and 2.

21 22 Description of the Exemplary Embodiment

23
24 The angular gear, sketched in an exploded view in Fig.
25 1, for a hand power tool as an exemplary embodiment for a
26 gear mechanism in general has a drive shaft 11, which can be
27 driven by an electric motor; a driving gear wheel 12, seated
28 in a manner fixed against relative rotation on the drive
29 shaft 11 and embodied here as a conical pinion with pinion
30 gearing 121; a driven gear wheel 13 meshing with the driving
31 gear wheel 12, which driven gear wheel is embodied as a ring
32 gear with spur gearing 131; and a driven shaft 14, driven by
33 the driven gear wheel 13. The driven gear wheel 13 sits
34 without play, rotatably and axially nondisplaceably, on the

1 driven shaft 14; in the axial direction, it is braced on one
2 side on an annular shoulder 15 (Fig. 1) embodied on the
3 driven shaft 14 and on the other on a slaving device 16,
4 which is pressed onto the driven shaft 14 and is additionally
5 joined by force-locking to the driven shaft 14. The slaving
6 device 16 has both a ring 17, surrounding the driven shaft
7 14, and a plurality of radial ribs 18, in this exemplary
8 embodiment three of them, that are offset in the
9 circumferential direction and are embodied integrally with
10 the ring 17 or instead are in multiple parts. The driven
11 shaft 14, in the region of the ring 17, has two diametrically
12 located axial grooves 19, and the ring 17 has two
13 diametrically located cams 20, protruding from the inner
14 surface of the ring, which plunge in form-locking fashion
15 into the axial grooves 19. In the exemplary embodiment, the
16 radial ribs 18 are offset by equal circumferential angles and
17 each protrude centrally into pockets 21 that are integrally
18 formed in the driven gear wheel 13 at the same rotational
19 angle spacing as the radial ribs 18. The pockets 21 are each
20 defined in the circumferential direction by radially oriented
21 side walls 211. Two damping elements 22 of spring-elastic
22 material, such as rubber, are located in each pocket 21, and
23 each damping element 22 rests on one side on a radial rib 18
24 and on the other on a side wall 211 of the pocket 21. The
25 damping elements 22 are either inserted into the pockets 21
26 upon the assembly of the gear mechanism, or are solidly
27 joined beforehand to the radial ribs 18.

28
29 When the electric motor is switched on, the torque is
30 transmitted from the drive shaft 11 to the driven gear wheel
31 13 via the driving gear wheel 12. Since the driven gear wheel
32 13 is seated rotatably on the driven shaft 14, the driven
33 gear wheel 13 can initially rotate by a few degrees,
34 compressing the damping element 22 located behind it in the

1 direction of rotation, and then, via the radial ribs 18, it
2 can rotate the slaving device 16 and - since the slaving
3 device 16 is seated on the driven shaft 14 in a manner fixed
4 against relative rotation - it can drive the driven shaft 14.
5 Thus by means of the damping elements 22, rotation is made to
6 occurs in the driven gear wheel 13 even without rotation
7 occurring at the driven shaft 14. As a result of this delay,
8 the maximum acceleration that occurs is reduced, and the time
9 until the full idling rpm of the driven shaft 14 is reached
10 is prolonged. Thus the heavy load on the gearing between the
11 driving gear wheel 12 and the driven gear wheel 13 upon
12 startup is reduced.

13
14 In operation of the hand power tool, the striking of
15 the teeth between the pinion gearing 121 and the spur gearing
16 131 is damped by the damping elements 22, causing a marked
17 reduction in the gear rattling that is clearly perceptible in
18 conventional hand power tools, particularly upon startup or
19 shutdown of the hand power tool. The front damping elements
20 22, in terms of the direction of rotation, are particularly
21 decisive for this; they damp the impacts that occur counter
22 to the direction of rotation.

23
24 In work with the hand power tool, it sometimes happens
25 that the tool briefly catches in the workpiece. In work with
26 right angle grinders and cutting wheels, for instance, this
27 often occurs. In this catching, which is equivalent to a
28 brief blockage of the tool, extreme forces are exerted on the
29 gearings 121, 131 between the driving gear wheel 12 and the
30 driven gear wheel 13. These force peaks are effectively
31 attenuated by the damping elements 22, leading to a reduction
32 in the recoil moment that the user cannot fail to perceive,
33 thus making tool use more comfortable for the user. Overall,
34 the mechanical loads on the gear mechanism are reduced, which

1 leads to longer service lives and perceptibly greater
2 comfort, since gear vibrations, impacts and the like are
3 transmitted to the tool housing only greatly attenuated.

4
5 In the exemplary embodiment shown in Figs. 1 and 2, the
6 pockets 21 are embodied with a rectangular inside cross
7 section, which is defined in the circumferential direction by
8 two radial, flat side walls 211. The radial ribs 18 that
9 protrude into the pockets 21 have a rectangular cross
10 section. The damping elements 22 may have an arbitrary
11 geometry. In the exemplary embodiment, they are embodied for
12 instance as elastic roller-like bodies, which are oriented
13 parallel to the axis of the driven shaft 14. It is understood
14 that modified geometries of the pockets 21 and radial ribs 18
15 are possible, and the number of radial ribs 18 and
16 correspondingly the number of pockets 21 may also be varied.

17
18 Fig. 3 shows a matrix that illustrates possible
19 combinations of pocket geometries and radial rib geometries.
20 Various internal profiles of the pockets 21 are plotted in
21 the top line, while various profiles of the radial ribs 18
22 are plotted in the column on the left. All the pocket
23 profiles A, B, C and D may be combined with the corresponding
24 radial rib profiles in lines 1, 2, 3 and 4. The matrix is
25 self-explanatory, and so only a few of its special features
26 will be pointed out here:

27
28 In column C, the pocket 21, as in the exemplary
29 embodiment of Figs. 1 and 2, has flat side walls. In columns
30 A, B and D, the side walls are provided with convexities,
31 which can be embodied either in curved or angular form. Upon
32 the deformation of the damping elements 22, these convexities
33 accommodate a portion of the material of the damping elements
34 22, so that the spring properties of the damping elements 22

1 are improved. As shown in the left-hand column, the profiles
2 of the radial ribs 18 may be embodied as rectangular, wedge-
3 shaped, and rectangular with concavities (line 3) and
4 convexities (line 4). In all the instances of combinations of
5 the pocket profile and radial rib profile, the damping
6 elements 22 are braced, as before, on the radial rib 18 and
7 on the two side walls 211 of the pockets 21. In the
8 combinations A/1, A/2, A/3, B/3, C/3, and D/3, the damping
9 elements 22 are embodied as either spherical or roller-
10 shaped; in the case of the roller shape they extend in the
11 radial direction.